Note: Procedure used by 1976 NPS [illegible] GOODWIN 1971

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ESTIMATING THE IMPACT OF FOREST MANAGEMENT ON WATER QUALITY 1/

Preliminary Procedure

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Introduction

We now have tools and information available to aim our recommended program at water quality needs. In river basin planning we evaluate erosion and sediment production from forest land under present management and project such production under the recommended program. However, we have not determined whether or not the forest yields or can yield water meeting established water quality criteria for suspended sediment for water uses within and below the basin. We have not aimed our recommended program at meeting water quality needs, nor have we sought the water quality standards to use as goals of our management program. This we must do.

Early river basin work produced generalizations which stated that certain practices were causing excessive erosion and this erosion must be stopped. There was much arm waving, counter arguments and statements. The watershed advocates usually were stymied by the retort, "Well, how much erosion can we stand?" We didn't know. Therefore, little progress was made in solving the watershed problem.

Recently, we moved into quantifying erosion and sediment production using a variety of techniques. It was then possible to get at least first approximations of total erosion and sediment production, and in some river basin studies, the impact of individual land management practices were quantified.

1/ Presented at: Cooperative Watershed Management Workshop, U. S. Forest Service, Memphis, Tennessee, October 4-8, 1971.

Again, erosion problems were pointed out to timber, fire and engineering people. For example, timber people were told site preparation with KG blade and root raking caused an average of 42 tons of erosion and 12 tons of sediment production per acre per year. The watershed people described these rates as excessive and argued for their elimination. A storm of an "arm waving" would ensue and the classic retort would be aired, "Well, how much erosion is acceptable?" Then, the controversy degenerated into using generalized statements, such as protecting site fertility, fishery, etc. As a result, very little was accomplished because we did not know what was an acceptable rate of erosion and usually they continued the practices without change.

During the new quantification era, watershed people discovered that the SCS had developed T-factors for most soil series. The T-factor is the amount of soil a site can loose in tons per acre per year without reducing soil fertility. The T-factor ranges between 1 and 5. To loose T tons means the complete removal of T tons from the site, which usually means sediment production.

I have read statements in river basin reports that the forest land has an average erosion rate of less than the average T-factor for the basin. Therefore, the present forest land management was doing the job. In the southeast, the average T-factor for a basin can be as high as 4 tons. If we accept this as the acceptable soil loss from forest land, we may have streams carrying 2,560 tons of sediment per square mile per year. This is certainly not satisfactory from the standpoint of water quality.

The problem is we have not defined the objectives of forest management except with generalized statements such as "improving the soil and water resources." The question should be, "What is the needed quality of soil and water resources?" Without specific goals, we will not have much direction in the recommended programs.

But we cannot develop definitive goals without adequate definition of needs. For suspended sediment, water quality criteria for water uses within and below the basin must be defined. These criteria should be available from the Environmental Protection Agency and State Agencies. If not, we can inventory the water uses and consult general criteria established by EPA. Examples of these are presented in Tables 1 and 2. In the Southeast, suspended solids are mostly soil particles where industrial and municipal pollution are not problems.

Some water quality criteria are expressed in Jackson Turbidity Units (JTU). JTU's measure turbidity by measuring light penetration through a suspension. The relationship between JTU's and suspended solids can be developed by land resource areas. Chart 1 shows this relationship for some of the Southeastern land resource areas.

Therefore, we can develop a list of water quality criteria and evaluate forest management with respect to the most restrictive of the criteria. This requires converting erosion and sediment production estimates into suspended sediment concentrations.

<u>New Procedure - FASS</u>

In the Southeastern Area, we are developing a new procedure to give first approximations of the impact of individual management practices on suspended sediment concentrations. We have named the procedure "First Approximation of Suspended Sediment" (FASS). FASS reveals suspended sediment problems and helps in prescribing management modifications and in comparing alternatives.

Basically, this procedure is an extension of our present erosion and sediment production evaluation. As the evaluation is presently conducted, the basins are stratified using soils, vegetation, land ownership and land use. Significant strata are field sampled for hydrologic condition, erosion and sediment production, management problems and program development. Erosion and sediment production rates are developed for each strata and land treatment using the modified Musgrave equation. We estimate what proportion of the erosion reaches the nearest stream, and thus, approximate sediment production. The sediment delivery estimate is based upon tracing the soil movement downhill and subtracting erosion that is trapped by obstructions. The total sediment production from all sources can be checked against reservoir sedimentation and suspended sediment data for the basin. The accuracy of the check data can vary widely due to the frequency and quality of sampling. Thus, the check may or may not be meaningful. If good check data is available and the estimate of sediment production varies significantly from it, adjustments are in order.

We are modifying this procedure by refining our sediment delivery estimate to approximate suspended sediment and bed load contributions. In the slow moving streams, silts and clays are probably carried in suspension with the sands going to bed load. In steep gradient mountain streams fine sands will also be carried in suspension.

The question becomes, "How can we approximate the quantity of fines and sands that reach a stream?" By determining soil texture we can roughly approximate the percentage of fines and sands in the soil using the textural triangle.

We then estimate what percent of the fines and what percent of the sands reach the stream. For example:

> A clay loam soil has approximately 35 percent sands and 65 percent fines. We estimate that 20 percent of the sands and 70 percent of the fines reach the stream. Thus, if the plot is eroding at 10 tons per acre per year, the plot is yielding 0.7 tons of sands and 4.55 tons of fines per acre per year.

Next, how is sediment production converted into suspended sediment concentrations? Research has generally demonstrated that 90 percent of the sediment is carried by stormflow. The remaining 10 percent is carried by baseflow. Therefore, suspended sediment concentrations must be approximated for both stormflow and baseflow periods.

The first step is to determine the quantity of stormflow. This is readily calculated using the U.S.G.S. water supply papers. Baseflow is the difference between annual runoff and storm runoff. For example: Fairforest Creek near Union, South Carolina, 1967-9:

Stormflow	6.8 inches
Baseflow	10.6 inches
Annual Runoff	17.4 inches

The second step is to develop a conversion factor for tons per inch of runoff to mg/l of stormflow and baseflow. The derivation is as follows assuming a representative acre.

(a) 1 Ton = 907,185,000 mg

(b) 1 acre inch of water = 102,787 Liters

(c) 6.8 inches of stormflow = 698,952 Liters

(d) = (a)÷(c) 1 Ton/6.8 in. stormflow = 1,298 mg/l

(e) 10.6 inches of baseflow = 1,089,952 Liters

(f) = (a)÷(e) 1 Ton/10.6 in. baseflow = 832 mg/l

The third step is convert average sediment production rates for land treatments to suspended sediment concentrations. For illustration, let's consider the impact of mechanical site preparation on suspended sediment for an ownership in the Santee River Basin. The remaining trees are felled with a KG blade held 4 to 6 inches above the ground. The felled material is windowed with a root rake again held 4 inches above the ground. This treatment leaves initially an average of 80 percent bare ground. This is the standard site preparation for the ownership and requires 4 years to heal. The average sediment production rate for this period is 12 tons per acre per year. Finally, this ownership operates under even-aged management and on an 80 year rotation, therefore, the percent of the area yielding this quantity of sediment would be 4 years divided by 80 years, or 5 percent.

The contribution to suspended sediment during stormflow is computed as follows:

(a) 1 Ton/6.8 in. stormflow = 1,298 m/l

(b) Sediment production assigned to stormflow equals 90 percent times 12 Tons = 10.8 Tons

(a)x(b)=(c) If all the ownership was yielding 10.8 Tons/ac/yr., the suspended sediment concentration would be 14,018 mg/l

(d) However, only 5 percent of the area is yielding this sediment. Therefore, the suspended sediment concentration is only 5 percent of (c), or the average during stormflow periods is 701 mg/l. (See Tables 3 & 4)

Likewise, the contribution to baseflow suspended sediment is computed as follows:

(a) 1 Ton/10.6 inches of baseflow = 832 mg/l.

(b) Sediment production assigned to baseflow equals 10 percent times 12 tons = 1.2 Tons.

(c) If all the ownership was yielding 1.2 Tons/ac/yr., the suspended sediment concentration would be 998 mg/l.

(d) However, only 5 percent of the area is contributing. Therefore, the average suspended sediment concentration during the baseflow period is 50 mg/l. (See Tables 3 & 4)

These suspended sediment contributions must be added to those produced by other land disturbances. The following table presents such a composite picture.

Sources	Suspended Sediment Stormflow	Concentrations Baseflow
	mg/l	
Badly eroding dirt roads	123	8
Paved Roads	47	3
Skid Trails	17	1
Site Preparation	701	50
Totals	988	62

The question then becomes, "Is this land yielding water that meets the water quality standards for uses in and below the basin?" In this basin, water is used for aesthetics, boating and fishing along streams and in reservoirs, municipal water supply, manufacturing textiles and fine paper, and shellfish culture in the estuary. From Tables 1 and 2 we can find the water quality criteria for these uses.

Use	Turbidity (mg/l) 1/ Optimum	Maximum
Aesthetics	50	
Boating	10	50
Fishing	10	50
Propagation	5	10
Municipal Water Supply	5	20
Textiles	5	
Pulp and Paper - Fine Paper	10	
Shellfish Culture	5	20

1/ At these low levels, ppm are convertible directly to mg/l with less than 1 percent error.

What should be the goal of our recommended program? We should aim our management at least at the uses where the water cannot be treated before use, that is, aesthetics, boating, fishery, and shellfish culture. Because of health standards, domestic water is purified before use. Textile and fine paper manufacturers usually have water treatment plants to treat muddy water during stormflows when turbidity is the highest.

Proper upstream management might eliminate the need to operate these plants during baseflow periods. Aesthetics, boating fishery and shellfish culture can stand short periods of high turbidity.

Therefore, we might aim our management at meeting baseflow water quality standards. However, there are several reservoirs downstream which trap slugs of storm runoff. The silts and clays in these slugs are extremely slow to settle out and adversely affect the reservoir's aesthetics, boating and fishery.

Thus, our management goals should be aimed at meeting water quality standards during both stormflow and baseflow periods. Our water quality target for stormflow and baseflow should be at least 50 and 5 mg/l, respectively. Therefore, the program must reduce the present stormflow concentration from 988 to 50 mg/l and baseflow from 62 to 5 mg/l.

The problem now becomes prescribing management and treatment modifications that will reduce suspended sediment to these levels. We have several sources of information and tools we can use to prescribe management direction. First, our field sampling should have identified what good management yields in erosion and sediment production. The field data identifies the conditions producing the present erosion and sediment production by treatment or problem area. Second, the Musgrave equation can prescribe treatment standards that reduce erosion and sediment production to acceptable levels. Third, FASS can prescribe the acceptable percent of the basin that can be in a particular condition, rotations, types of silvicultural systems, acceptable erosion and sediment production rates by area and extent of a land use, and evaluate alternatives of land use.

For the composite example, a possible recommended program for each of these problems is presented to illustrate the use of these tools. Badly eroding dirt roads, paved roads, skid trails, and site preparation were yielding 988 and 62 mg/l in stormflow and baseflow, respectively. The dirt roads occupy 0.25 percent of the area and yield 42 tons of sediment per acre of roads per year. Paved roads are yielding 2 tons. We could recommend that the dirt roads be paved and the cut and fill slopes stabilized. Thus, dirt roads should then yield sediment at a rate of 2 T/A/Yr. Using Table 4, The suspended sediment contribution would be reduced from 123 to 6 mg/l for stormflow and from 8 to essentially zero mg/l for baseflow.

The paved roads occupy 2 percent of the area and are contributing important quantities of suspended sediment. This sediment comes from occasional eroding cut banks, gullies in road drainage, and areas unnecessarily exposed by grading. Field data might show the most stable sections of road are yielding only 0.4 Tons per acre per year of sediment production. The recommendations could be (1) stabilize eroding cutbanks, (2) exclude unnecessary grading, and (3) if some road drainage is graded, stabilize the area exposed with vegetation or a material that will not erode. Therefore, using Table 4, we can expect the paved roads to contribute only 9 mg/l to stormflow and 1 mg/l to baseflow.

Skid trails occupy 0.25 percent of the area and yield 5.5 T/A/Yr. of sediment. They have an average of 38 percent bare ground, 15 percent slope and slope length of 60 feet. These trails were not seeded to grass and run up and down slope. Using the Musgrave equation, we can evaluate average watershed treatments. For example, the recommendations are (1) seed the skid trails to grass to reduce the bare ground to 5 percent, (2) limit the average slopes of skid trails to 10 percent, and (3) space water bars an average of 40 feet apart.

(Actually in the future, we hope to develop a set of drainage intervals for varying slopes). Based upon the average present conditions, the Musgrave equation computes an erosion rate of 54 T/A/Yr. The present sediment production rate is 5.5 T/A/Yr. Therefore, the average sediment delivery ratio is 0.10. With the recommended treatments, the erosion rate should be 3.5 T/A/Yr. Assuming the same sediment delivery ratio of .10, the expected sediment production rate should be approximately .4 T/A/Yr. Therefore using Table 4 the expected sediment contribution to stormflow should be 1 mg/l and zero to baseflow.

So far, the future expected sediment concentrations add up to 18 and 1 mg/l respectively, for stormflow and baseflow. Therefore, site preparation can be allowed to contribute 32 and 4 mg/l to stormflow and baseflow, respectively. Using Table 3, sediment production from site preparation cannot exceed an average of 0.6 T/A/Yr. for the four year recovery period. The present rate is 12 T/A/Yr. The solution of this problem lies in modifying the size, shape and extent of areas treated with mechanical site preparation.

Presently, site preparation occupies 5 percent of the area, and averages 10 percent slope, 150 feet in slope lengths, and 80 percent bare ground initially. All four of these factors can be manipulated. We can recommend that the erosion must be reduced by a factor of 20 and prescribe after treatment conditions using Musgrave. For example, if slope and slope length are held constant, the percent bare ground would have to be reduced to 4 percent to produce 1/20 the erosion. This is almost impossible with mechanical site preparation. Therefore, average slope and slope length must be manipulated too.

The resulting proposal might be to limit the initial percent bare ground to 30 percent, the average slope to 5 percent, and average slope lengths to 80 feet. Erosion would be reduced by 88 percent and sediment production by at least a like amount. Therefore, this proposal should make sediment production 1.4 T/A/Yr.

The next step would be to check some of the best mechanical site preparation work and see if such a proposal is realistic. We found in South Carolina, that this is realistic when the root raking is eliminated. However, from Table 3, the average sediment production rate of 1.4 T/A/Yr. contributes 71 mg/l to stormflow and 6 mg/l to baseflow. Unfortunately, the acceptable contribution is only ~~34~~ 32 and 4 mg/l, respectively for stormflow and baseflow.

Therefore, the only alternative left is to reduce the percent of the basin yielding sediment from mechanical site preparation. The percent area in mechanical site preparation is reduced by one of two methods. First, increase the rotation age, thereby reducing the frequency and area of site preparation. The sediment concentration needs to be reduced by a factor of 2. Therefore, the rotation age would have to be increased by a factor of 2. In this case, the rotation would have to be increased from 80 to 160 years. This would conflict with timber needs.

The second alternative is to search for other suitable means of regeneration, such as, injection and hand planting. In this example, if one half the area was regenerated by hand, the sediment contributions from site preparation would be 35 and 3 mg/l for stormflow and baseflow, respectively. Such a mixture of regeneration techniques would cause this ownership to yield water that meets water quality needs.

A neighboring ownership is managing its land for pulpwood, with a rotations of 25 to 30 years on the same soil group as the above ownership. The frequency of logging and site preparation may cause sediment concentrations that exceed water quality needs even with the best of treatments. The resulting recommendation for this soil group might be to grow sawtimber instead and recommend pulpwood production be limited to a suitable group of soils.

Future Development of Technique

A computer program will be developed to produce a set of tables to help the river basin planner make these recommendations. Tables 3 and 4 are examples of such tables, which the planner can use to evaluate alternatives at a glance. These tables were used in the above examples.

Ultimately, maps for baseflow and storm runoff will be developed for the Southeast from which the planner can quickly determine baseflow and storm runoff for his study area. For each iso-runoff line, charts similar to Chart 2 will be supplied. These charts are used to project suspended sediment from sediment production for one percent of the area. The planner then multiplies this concentration by the percentage of the area producing this sediment. For example, 5 percent of the area is yielding 10 T/A/Yr. Projecting up from 10 T/A/Yr. to the baseflow line produces a concentration of 8 mg/l. Next the 8 mg/l is multiplied by 5 to produce 40 mg/l. Therefore, 10 T/A/Yr. from 5 percent of the area produces 40 mg/l of suspended sediment in baseflow. These charts can be used for most studies.

Conclusions

Past experience has taught us that generalizations have proved to be ineffective in solving watershed needs. Our study objectives are stated as generalizations. We have not clearly defined our needs and goals for soil and water resources. This we must do. We have the information and the tools available to make our recommended programs more needs orientated. FASS provides one step in this direction and similar procedures must be developed for other facets of our work. Our reports are only as pertinent as our ability to define needs and to recommend realistic programs to meet these needs.

Table 1. Water quality criteria for turbidity and suspended solids for various uses 1/

Use	Turbidity (ppm)		Suspended Solids (ppm)	
	Optimum	Maximum	Optimum	Maximum
Domestic water supply	5	20	10	100
Swimming	5	20	50	100
Boating & fishing	10	50		
Wildlife propagation				
Fresh water	5	10	10	20
Salt water	5	20	10	50
Fowl refuge	10	100	10	100
Shellfish culture	5	50	10	100
Food processing	5	20	10	50
Aesthetic	50			

1/ Source: The Water Encyclopedia, Water Information Center, Port Washington, N.Y., pgs. 312-313, 1970.

Table 2. Water quality criteria for suspended solids for industrial uses 1/

Use	Suspended Solids MG/L	Use	Suspended Solids MG/L
Baking	10	Rayon (viscose)	
Boiler feed		Pulp production	5
0-150 psi.	20	Manufacture	0.3
150-240 psi.	10	Steel Manufacturing	
250-400 psi.	5	Instantaneous max.	50 2/
400+psi.	1	Monthly average	25 2/
Brewing	10	Tanning	20
Canning	10	Textiles	
Carbonated beverages	2	General	5
Cooling	50	Dyeing	5
Food-general	10	Cotton Bandage	5
Ice	5		
Plastics, clear			
uncolored	2		
Pulp and Paper			
Groundwood	50		
Kraft, bleached	40		
Soda and sulphate	25		
Fine paper	10		

1/ The Water Encyclopedia, Water Information Center, Port Washington, N.Y., 1920.

2/ Water Quality Criteria, California State Water Quality Control Board, Sacremento, California, Publ. No. 3-A, 1963.

Table 3. Sediment Production From Site Preparation (KG) as Influenced By Rotation Age

4 Yr verage diment duction	90% Sediment To Storm Runoff	10% of Sediment To Baseflow	Suspended Sediment in Storm Runoff by Rotation						Suspended Sediment in Baseflow By Rotation					
			Rotations						Rotations					
			30 yrs	40 yrs	50 yrs	60 yrs	70 yrs	80 yrs	30 yrs	40 yrs	50 yrs	60 yrs	70 yrs	80 yrs
T/A/Yr	T/A/Yr	T/A/Yr			mg/L						mg/L			
.1	.09	.01	16	12	9	8	7	6	1	1	1	1		
.2	.18	.02	31	23	19	16	13	12	2	2	1	1	1	1
.4	.36	.04	62	47	37	31	27	23	4	3	3	2	2	2
.6	.54	.06	93	70	56	47	40	35	7	5	4	3	3	3
.8	.72	.08	125	94	75	63	53	47	9	7	5	4	4	3
1.0	.90	.1	156	117	94	78	67	59	11	8	7	6	5	4
2.0	1.80	.2	311	234	187	157	133	117	22	17	13	11	9	8
4.0	3.6	.4	623	468	374	313	266	234	44	33	27	22	19	17
6.0	5.4	.6	934	702	562	470	400	351	67	50	40	34	28	25
8.0	7.2	.8	1,246	936	748	626	533	468	89	66	54	45	38	34
10.0	9.0	1.0	1,557	1,170	936	783	666	585	111	83	67	56	47	42
12.0	10.8	1.2	1,868	1,404	1,123	940	799	701	133	100	80	67	56	50
14.0	12.6	1.4	2,180	1,638	1,310	1,096	932	819	155	116	94	78	66	59
16.0	14.4	1.6	2,491	1,872	1,498	1,253	1,066	936	178	133	107	90	75	67
18.0	16.2	1.8	2,802	2,106	1,685	1,409	1,199	1,053	200	149	121	101	85	76
20.0	18.0	2.0	3,114	2,340	1,872	1,566	1,332	1,170	222	166	134	112	94	84
25.0	22.5	2.5	3,893	2,925	2,340	1,958	1,665	1,463	278	208	168	140	118	105
30.0	27.0	3.0	4,671	3,510	2,808	2,349	1,998	1,755	333	249	201	168	141	126
35.0	31.5	3.5	5,450	4,095	3,276	2,741	2,331	2,048	389	291	235	196	165	147
40.0	36.0	4.0	6,228	4,680	3,744	3,132	2,664	2,340	444	332	268	224	188	168
45.0	40.5	4.5	7,007	5,265	4,212	3,524	2,997	2,633	500	374	305	252	212	189
50.0	45.0	5.0	7,785	5,850	4,680	3,915	3,330	2,925	555	415	335	280	235	210
55.0	49.5	5.5	8,564	6,435	5,148	4,307	3,663	3,218	611	457	369	308	259	231
60.0	54.0	6.0	9,342	7,020	5,616	4,698	3,996	3,510	666	498	402	336	282	252
65.0	58.5	6.5	10,121	7,605	6,084	5,090	4,329	3,803	722	540	436	364	306	273
70.0	63.0	7.0	10,899	8,190	6,552	5,481	4,662	4,095	777	581	469	392	329	294
80.0	72.0	8.0	12,456	9,360	7,488	6,264	5,328	4,680	888	664	536	448	376	336
90.0	81.0	9.0	14,013	10,530	8,424	7,047	5,994	5,265	999	747	603	504	423	378
100.0	90.0	10.0	15,570	11,700	9,360	7,830	6,660	5,850	1,110	830	670	560	470	420

Table 4. Suspended Sediment Concentrations By Percent of Area Yielding Sediment

iment Product.	Stormflow Concentrations							Baseflow Concentrations						
	.25%	.5%	1.0%	2.0%	5.0%	10.0%	20.0%	.25%	.5%	1.0%	2.0%	5.0%	10%	20%
T/Ac/Yr				mg/L							mg/L			
.1		1	1	2	6	12	23						1	2
.2	1	1	2	5	12	23	47					1	2	3
.4	1	2	5	9	23	47	93				1	2	3	7
.6	2	4	7	14	35	70	140				1	2	5	10
.8	2	5	9	19	47	93	187			1	1	3	7	13
1.0	3	6	12	23	58	117	234			1	2	4	8	17
2.0	6	12	23	47	116	234	467		1	2	3	8	17	33
4.0	12	23	47	93	234	467	935	1	2	3	7	17	33	67
6.0	18	35	70	140	350	701	1,402	1	2	5	10	25	50	100
8.0	23	47	93	187	467	935	1,869	2	3	7	13	33	67	133
10.0	29	58	117	234	584	1,168	2,336	2	4	8	17	42	83	167
12.0	35	70	140	280	701	1,402	2,804	2	5	10	20	50	100	200
14.0	41	82	164	327	818	1,635	3,271	3	6	12	23	58	117	233
16.0	47	93	187	374	935	1,869	3,738	3	7	13	27	67	133	267
18.0	53	105	210	420	1,051	2,103	4,206	4	7	15	30	75	150	300
20.0	59	117	234	467	1,168	2,336	4,673	4	8	17	33	83	167	333
25.0	73	146	292	584	1,460	2,921	5,841	5	10	21	42	104	208	417
30.0	88	175	350	701	1,752	3,505	7,009	6	12	25	50	125	250	500
35.0	103	204	409	818	2,044	4,089	8,177	7	15	29	58	146	292	583
40.0	117	234	467	934	2,336	4,673	9,346	8	17	33	67	167	333	666
45.0	132	263	526	1,051	2,628	5,257	10,514	9	19	37	75	187	375	750
50.0	147	292	584	1,168	2,951	5,841	11,682	10	21	42	83	208	417	833
55.0	161	321	642	1,285	3,213	6,425	12,850	11	23	46	92	229	458	916
60.0	176	350	701	1,402	3,505	7,009	14,018	12	25	50	100	250	500	1,000
65.0	190	380	759	1,518	3,797	7,593	15,187	14	27	54	109	271	541	1,083
70.0	205	409	818	1,635	4,089	8,177	16,355	15	29	58	117	292	583	1,166
80.0	234	467	934	1,869	4,673	9,346	18,691	17	33	67	133	333	666	1,333
90.0	264	526	1,051	2,102	5,257	10,514	21,028	19	37	75	150	375	750	1,499
100.0	293	584	1,168	2,336	5,841	11,682	23,364	21	42	83	167	417	833	1,666

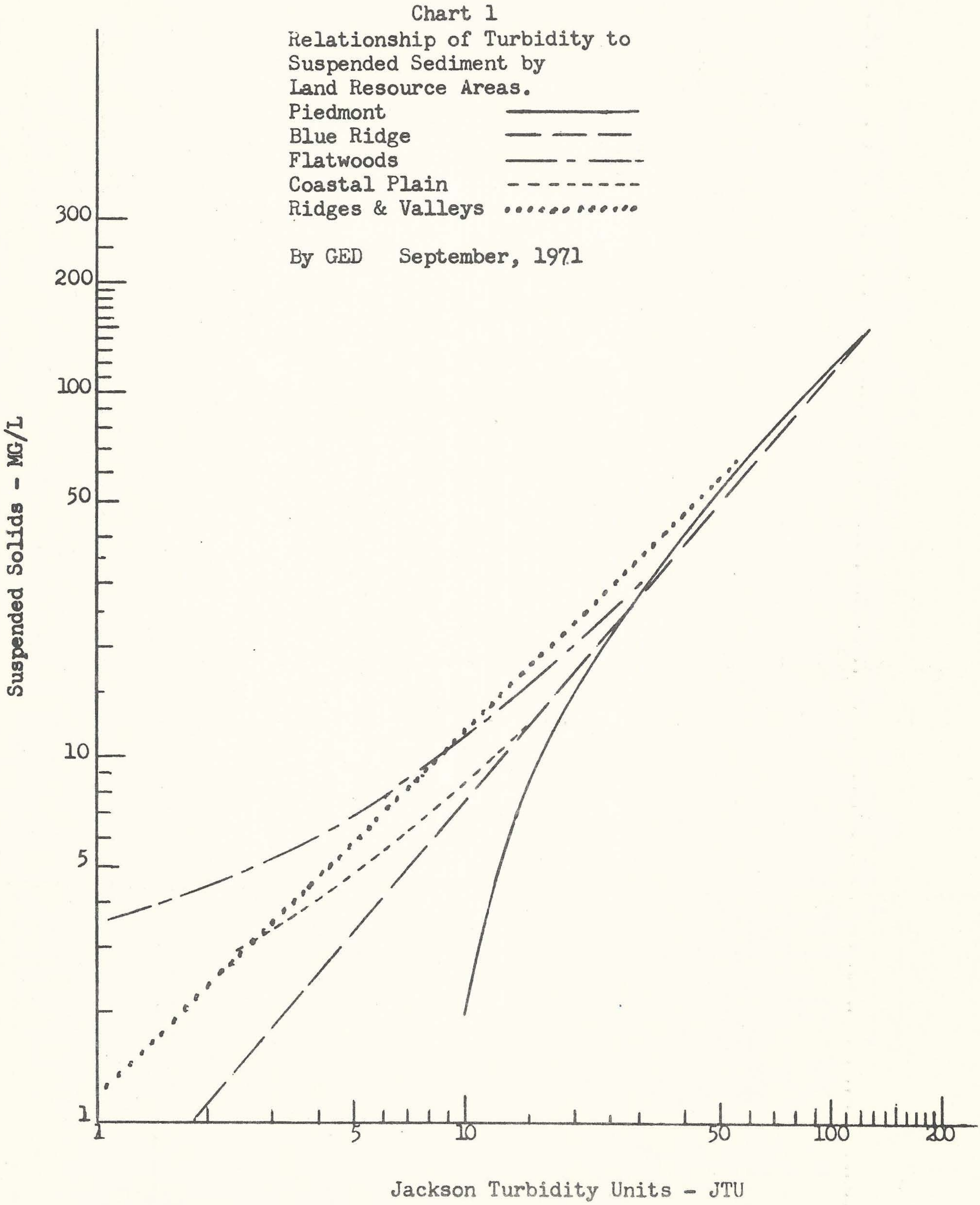
Chart 1
Relationship of Turbidity to
Suspended Sediment by
Land Resource Areas.
Piedmont
Blue Ridge
Flatwoods
Coastal Plain
Ridges & Valleys
By GED September, 1971
300
200
100
50
10
5
1
1
5
10
50
100
200
Suspended Solids - MG/L
Jackson Turbidity Units - JTU

Chart 2
Stormflow And Base Flow
Suspended Sediment Concentrations
For Sediment Production Rates From
Contributing Area of One Percent
For Lands Near Union, S. C.